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(54) Self-sealing fluid interconnect with double sealing septum

Selbstschliessende Flüssigkeitsverbindung mit doppelter Abdichtungswand

Dispositif d'interconnexion pour fluide à fermeture automatique avec double septum d'étanchéité

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(73) Proprietor:
Hewlett-Packard Company
Palo Alto, California 94304 (US)

(72) Inventors:
- **Barlnaga, John A.**
  Corvallis, OR 97330 (US)
- **Clark, James E.**
  Albany, OR 97321 (US)
- **Merrill, David O.**
  Corvallis, OR 97330 (US)
- **Nguyen, Ngoc-Diep**
  Vancouver, WA 98683 (US)
- **Otis, David R., Jr.**
  Corvallis, OR 97330 (US)

(74) Representative:
Colgan, Stephen James
CARPMAELS & RANSFORD
43 Bloomsbury Square
London WC1A 2RA (GB)

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Figure 4 is a bottom view of the chassis of Figure 3.

Figure 5 is a top perspective view of the pressure plate of the ink supply of Figure 1.

Figure 6 is a bottom perspective view of the pressure plate of Figure 5.

Figure 7 is an exploded, cross sectional view of an alternative embodiment of a pump for use in an ink supply in accordance with the present invention.

Figure 8 shows the ink supply if Figure 1 being inserted into a docking bay of an ink-jet printer.

Figure 9 is a cross sectional view of a part of the ink supply of Figure 1 being inserted into the docking bay of an ink-jet printer, taken along line 9-9 of Figure 8.

Figure 10 is a cross sectional view showing the ink supply of Figure 9 fully inserted into the docking bay.

Figure 11 shows the docking bay of Figure 8 with a portion of the docking bay cutaway to reveal an out-of-ink detector.

Figures 12A-12E are cross sectional views of a portion of the ink supply and docking bay showing the pump, actuator and out-of-ink detector in various stages of operation, taken along line 12-12 of Figure 11.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

[0014] Art ink supply in accordance with a preferred embodiment of the present invention is illustrated in Figure 1 as reference numeral 20. The ink supply 20 has a chassis 22 which carries an ink reservoir 24 for containing ink, a pump 26 and fluid outlet 28. The chassis 22 is enclosed within a hard protective shell 30 having a cap 32 affixed to its lower end. The cap 32 is provided with an aperture 34 to allow access to the pump 26 and an aperture 36 to allow access to the fluid outlet 28.

[0015] To use the ink supply 20, it is inserted into a docking bay 38 of an ink-jet printer, as illustrated in Figures 8-11. Upon insertion of the ink supply 20, an actuator 40 within the docking bay 38 is brought into contact with the pump 26 through aperture 34. In addition, a fluid inlet 42 within the docking bay 38 is coupled to the fluid outlet 28 through aperture 36 to create a fluid path from the ink supply to the printer. Operation of the actuator 40 causes the pump 26 to draw ink from the reservoir 24 and supply the ink through the fluid outlet 28 and the fluid inlet 42 to the printer.

[0016] Upon depletion of the ink from the reservoir 24, or for any other reason, the ink supply 20 can be easily removed from the docking bay 38. Upon removal, the fluid outlet 28 and the fluid inlet 42 are closed to help prevent any residual ink from leaking into the printer or onto the user. The ink supply may then be discarded or stored for reinstallation at a later time. In this manner, the present ink supply 20 provides a user of an ink-jet printer a simple, economical way to provide a reliable, and easily replaceable supply of ink to an ink-jet printer.

[0017] As illustrated in Figures 1-4, the chassis 22 has a main body 44. Extending upward from the top of the chassis body 44 is a frame 46 which helps define and support the ink reservoir 24. In the illustrated embodiment, the frame 46 defines a generally square reservoir 24 having a thickness determined by the thickness of the frame 46 and having open sides. Each side of the frame 46 is provided with a face 48 to which a sheet of plastic 50 is attached to enclose the sides of the reservoir 24. The illustrated plastic sheet is flexible to allow the volume of the reservoir to vary as ink is depleted from the reservoir. This helps to allow withdrawal and use of all of the ink within the reservoir by reducing the amount of backpressure created as ink is depleted from the reservoir. The illustrated ink supply 20 is intended to contain about 30 cubic centimeters of ink when full. Accordingly, the general dimensions of the ink reservoir defined by the frame are about 57 millimeters high, about 60 millimeters wide, and about 5.25 millimeters thick. These dimensions may vary depending on the desired size of the ink supply and the dimensions of the printer in which the ink supply is to be used.

[0018] In the illustrated embodiment, the plastic sheets 50 are heat staked to the faces 48 of the frame in a manner well known to those in the art. The plastic sheets 50 are, in the illustrated embodiment, multi-ply sheets having an outer layer of low density polyethylene, a layer of adhesive, a layer of metallized polyethylene terephthalate, a layer of adhesive, a second layer of metallized polyethylene terephthalate, a layer of adhesive, and an inner layer of low density polyethylene. The layers of low density polyethylene are about 0,0127 mm (0.0005 inches) thick and the metallized polyethylene terephthalate is about 0,01219 mm (0.00048 inches) thick. The low density polyethylene on the inner and outer sides of the plastic sheets can be easily heat staked to the frame while the double layer of metallized polyethylene terephthalate provides a robust barrier against vapor loss and leakage. Of course, in other embodiments, different materials, alternative methods of attaching the plastic sheets to the frame, or other types of reservoirs might be used.

[0019] The body 44 of the chassis 22, as seen in Figures 1-4, is provided with a fill port 52 to allow ink to be introduced into the reservoir. After filling the reservoir, a plug 54 is inserted into the fill port 52 to prevent the escape of ink through the fill port. In the illustrated embodiment, the plug is a polypropylene ball that is press fit into the fill port.

[0020] A pump 26 is also carried on the body 44 of the chassis 22. The pump 26 serves to pump ink from the reservoir and supply it to the printer via the fluid outlet 28. In the illustrated embodiment, seen in Figures 1 and 2, the pump 26 includes a pump chamber 56 that is integrally formed with the chassis 22. The pump chamber is defined by a skirt-like wall 58 which extends downwardly from the body 44 of the chassis 22.

urges the spring to its original configuration, thereby biasing the lower face downward to expand the volume of the chamber 56a. The unitary spring/pressure plate 92 may be formed of various suitable materials such as, for example, HYTREL.

[0030] In this embodiment, the valve 64a is a flapper valve that is held in position on the shoulder 90 of the pump inlet 60a by the top of the mounting stem 98. The mounting stem 98 has a cross shaped cross section which allows the flapper valve 64a to deflect downward into four open quadrants to allow ink to flow from the ink reservoir into the chamber. The shoulder prevents the flapper valve from deflecting in the upward direction to limit the flow of ink from the chamber back into the reservoir. Rather, ink exits the chamber via the pump outlet 62. It should be appreciated that the mounting stem may have a "V" cross section, an "I" cross section, or any other cross section which allows the flapper valve to flex sufficiently to permit the needed flow of ink into the chamber.

[0031] As illustrated in Figure 2, a conduit 84 joins the pump outlet 62 to the fluid outlet 28. In the illustrated embodiment, the top wall of the conduit 84 is formed by the lower member of the frame 46, the bottom wall is formed by the body 44 of the chassis, one side is enclosed by a portion of the chassis and the other side is enclosed by a portion of one of the plastic sheets 50.

[0032] As illustrated in Figures 1 and 2, the fluid outlet 28 is housed within a hollow cylindrical boss 99 that extends downward from the chassis 22. The top of the boss 99 opens into the conduit 84 to allow ink to flow from the conduit into the fluid outlet. A spring 100 and sealing ball 102 are positioned within the boss 99 and are held in place by a compliant septum 104 and a crimp cover 106. The length of the spring 100 is such that it can be placed into the inverted boss 99 with the ball 102 on top. The septum 104 can then inserted be into the boss 99 to compress the spring 100 slightly so that the spring biases the sealing ball 102 against the septum 104 to form a seal. The crimp cover 106 fits over the septum 104 and engages an annular projection 108 on the boss 99 to hold the entire assembly in place.

[0033] In the illustrated embodiment, both the spring 100 and the ball 102 are stainless steel. The sealing ball 102 is sized such that it can move freely within the boss 99 and allow the flow of ink around the ball when it is not in the sealing position. The septum 104 is formed of polyisoprene rubber and has a concave bottom to receive a portion of the ball 102 to form a secure seal. The septum 104 is provided with a slit 110 so that it may be easily pierced without tearing or coring. However, the slit is normally closed such that the septum itself forms a second seal. The slit may, preferably, be slightly tapered with its narrower end adjacent the ball 102. The illustrated crimp cover 106 is formed of aluminum and has a thickness of about 0,508 mm (0.020 inches). A hole 112 is provided so that the crimp cover 106 does not interfere with the piercing of the septum 104.

[0034] With the pump and fluid outlet in place, the ink reservoir 24 can be filled with ink. To fill the ink reservoir 24, ink can be injected through the fill port 52. As ink is being introduced into the reservoir, a needle (not shown) can be inserted through the slit 110 in the septum 104 to depress the sealing ball 102 and allow the escape of any air from within the reservoir. Alternatively, a partial vacuum can be applied through the needle. The partial vacuum at the fluid outlet causes ink from the reservoir 24 to fill the chamber 56, the conduit 84, and the cylindrical boss 99 such that little, if any, air remains in contact with the ink. The partial vacuum applied to the fluid outlet also speeds the filling process. Once the ink supply is filled, the plug 54 is press fit into the fill port to prevent the escape of ink or the entry of air.

[0035] Of course, there are a variety of other methods which might also be used to fill the present ink supply. In some instances, it may be desirable to flush the entire ink supply with carbon dioxide prior to filling it with ink. In this way, any gas trapped within the ink supply during the filling process will be carbon dioxide, not air. This may be preferable because carbon dioxide may dissolve in some inks while air may not. In general, it is preferable to remove as much gas from the ink supply as possible so that bubbles and the like do not enter the print head or the trailing tube. To this end, it may also be preferable to use degassed ink to further avoid the creation or presence of bubbles in the ink supply.

[0036] Although the ink reservoir 24 provides an ideal way to contain ink, it may be easily punctured or ruptured and may allow some amount of water loss from the ink. Accordingly, to protect the reservoir 24 and to further limit water loss, the reservoir 24 is enclosed within a protective shell 30. In the illustrated embodiment, the shell 30 is made of clarified polypropylene. A thickness of about one millimeter has been found to provide robust protection and to prevent unacceptable water loss from the ink. However, the material and thickness of the shell may vary in other embodiments.

[0037] As illustrated in Figure 1, the top of the shell 30 has contoured gripping surfaces 114 that are shaped and textured to allow a user to easily grip and manipulate the ink supply 20. A vertical rib 116 having a detente 118 formed near its lower end projects laterally from each side of the shell 30. The base of the shell 30 is open to allow insertion of the chassis 22. A stop 120 extends laterally outward from each side of the wall 58 that defines the chamber 56. These stops 120 abut the lower edge of the shell 30 when the chassis 22 is inserted.

[0038] A protective cap 32 is fitted to the bottom of the shell 30 to maintain the chassis 22 in position. The cap 32 is provided with recesses 128 which receive the stops 120 on the chassis 22. In this manner, the stops are firmly secured between the cap and the shell to maintain the chassis in position. The cap is also provided with an aperture 34 to allow access to the pump

control the operation of the pump and to detect when an ink supply is empty.

[0048] As seen in Figure 9, the fluid inlet 42 is positioned within the housing 150 carried on the base plate 146. The illustrated fluid inlet 42 includes an upwardly extending needle 162 having a closed, blunt upper end 164, a blind bore 166 and a lateral hole 168. A trailing tube 169, seen in Figure 11, is connected to the lower end of the needle 162 in fluid communication with the blind bore 166. The trailing tube 169 leads to a print head (not shown). In most printers, the print head will usually include a small ink well for maintaining a small quantity of ink and some type of pressure regulator to maintain an appropriate pressure within the ink well. Typically, it is desired that the pressure within the ink well be slightly less than ambient. This "back pressure" helps to prevent ink from dripping from the print head. The pressure regulator at the print head may commonly include a check valve which prevents the return flow of ink from the print head and into the trailing tube.

[0049] A sliding collar 170 surrounds the needle 162 and is biased upwardly by a spring 172. The sliding collar 170 has a compliant sealing portion 174 with an exposed upper surface 176 and an inner surface 178 in direct contact with the needle 162. In addition, the illustrated sliding collar includes a substantially rigid portion 180 extending downwardly to partially house the spring 172. Art annular stop 182 extends outward from the lower edge of the substantially rigid portion 180. The annular stop 182 is positioned beneath the base plate 146 such that it abuts the base plate to limit upward travel of the sliding collar 170 and define an upper position of the sliding collar on the needle 162. In the upper position, the lateral hole 168 is surrounded by the sealing portion 174 of the collar to seal the lateral hole and the blunt end 164 of the needle is generally even with the upper surface 176 of the collar.

[0050] In the illustrated embodiment, the needle 162 is an eighteen gauge stainless steel needle with an inside diameter of about 1.04 millimeters, an outside diameter of about 1.2 millimeters, and a length of about 30 millimeters. The lateral hole is generally rectangular with dimensions of about 0.55 millimeters by 0.70 millimeters and is located about 1.2 millimeters from the upper end of the needle. The sealing portion 174 of the sliding collar is made of ethylene propylene dimer monomer and the generally rigid portion 176 is made of polypropylene or any other suitably rigid material. The sealing portion is molded with an aperture to snugly receive the needle and form a robust seal between the inner surface 178 and the needle 162. In other embodiments, alternative dimensions, materials or configurations might also be used.

[0051] To install an ink supply 20 within the docking bay 38, a user can simply place the lower end of the ink supply between the opposing walls 134 and 136 with one edge in one vertical channel 138 and the other edge in the other vertical channel 140, as shown in Figure 8. The ink supply is then pushed downward into the installed position, shown in Figure 10, in which the bottom of the cap 32 abuts the base plate 146. As the ink supply is pushed downward, the fluid outlet 28 and fluid inlet 42 automatically engage and open to form a path for fluid flow from the ink supply to the printer, as explained in more detail below. In addition, the actuator enters the aperture 34 in the cap 32 to pressurize the pump, as explained in more detail below.

[0052] Once in position, the engagement prongs 144 on each side of the docking station engage the detentes 118 formed in the shell 30 to firmly hold the ink supply in place. The leaf springs 142, which allow the engagement prongs to move outward during insertion of the ink supply, bias the engagement prongs inward to positively hold the ink supply in the installed position. Throughout the installation process and in the installed position, the edges of the ink supply 20 are captured within the vertical channels 138 and 140 which provide lateral support and stability to the ink supply. In some embodiments, it may be desirable to form grooves in one or both of the channels 138 and 140 which receive the vertical rib 116 formed in the shell to provide additional stability to the ink supply.

[0053] To remove the ink supply 20, a user simply grasps the ink supply, using the contoured gripping surfaces 114, and pulls upward to overcome the force of the leaf springs 142. Upon removal, the fluid outlet 28 and fluid inlet 42 automatically disconnect and reseal leaving little, if any, residual ink and the pump 26 is depressurized to reduce the possibility of any leakage from the ink supply.

[0054] Operation of the fluid interconnect, that is the fluid outlet 28 and the fluid inlet 42, during insertion of the ink supply is illustrated in Figures 9 and 10. Figure 9 shows the fluid outlet 28 upon its initial contact with the fluid inlet 42. As illustrated in Figure 9, the housing 150 has partially entered the cap 32 through aperture 36 and the lower end of the fluid outlet 28 has entered into the top of the housing 150. At this point, the crimp cover 106 contacts the sealing collar 170 to form a seal between the fluid outlet 28 and the fluid inlet 42 while both are still in their sealed positions. This seal acts as a safety barrier in the event that any ink should leak through the septum 104 or from the needle 162 during the coupling and decoupling process.

[0055] In the illustrated configuration, the bottom of the fluid inlet and the top of the fluid outlet are similar in shape. Thus, very little air is trapped within the seal between the fluid outlet of the ink supply and the fluid inlet of the printer. This facilitates proper operation of the printer by reducing the possibility that air will enter the fluid outlet 28 or the fluid inlet 42 and reach the ink jets in the print head.

[0056] As the ink supply 20 is inserted further into the docking bay 38, the bottom of the fluid outlet 28 pushes the sliding collar 170 downward, as illustrated in Figure 10. Simultaneously, the needle 162 enters the slit 110

mechanical switch, an electrical switch or some other switch capable of detecting the position of the actuator could be used in place of the optical detector.

[0067] The configuration of the present ink supply is particularly advantageous because only the relatively small amount of ink within the chamber is pressurized. The large majority of the ink is maintained within the reservoir at approximately ambient pressure. Thus, it is less likely to leak and, in the event of a leak, can be more easily contained.

[0068] The illustrated diaphragm pump has proven to be very reliable and well suited for use in the ink supply. However, other types of pumps may also be used. For example, a piston pump, a bellows pump, or other types of pumps might be adapted for use with the present invention.

[0069] As discussed above, the illustrated docking station 132 includes four side-by-side docking bays 38. This configuration allows the wall 134, the wall 136 and the base plate 146 for the four docking bays to be unitary. In the illustrated embodiment, the leaf springs for each side of the four docking bays can be formed as a single piece connected at the bottom. In addition, the cams 158 for each docking station are attached to a single shaft 160. Using a single shaft results in each of the four ink supplies being refreshed when the pump of any one of the four reaches its minimum operational volume. Alternatively, it may be desirable to configure the cams and shaft to provide a third position in which only the black ink supply is pressurized. This allows the colored ink supplies to remain at ambient pressure during a print job that requires only black ink.

[0070] The arrangement of four side-by-side docking bays is intended for use in a color printer. One of the docking bays is intended to receive an ink supply containing black ink, one an ink supply containing yellow ink, one an ink supply containing cyan ink, and one an ink supply containing magenta ink. The mating keys 139 for each of the four docking bays are different and correspond to the color of ink for that docking bay. The mating keys 139 are shaped to receive the corresponding keys 130 formed on a cap of an ink supply having the appropriate color. That is, the keys 130 and the mating keys 139 are shaped such that only an ink supply having the correct color of ink, as indicated by the keys on the cap, can be inserted into any particular docking bay. The mating keys 139 can also identify the type of ink supply that is to be installed in the docking bay. This system helps to prevent a user from inadvertently inserting an ink supply of one color into a docking bay for another color or from inserting an ink supply intended for one type of printer into the wrong type of printer.

Claims

1. A system for forming a fluid connection between a removable ink supply (20) containing a quantity of ink and an ink-jet printer into which the ink supply can be inserted, the ink-jet printer having a trailing tube (169) for supplying ink to an ink-jet print head, the system comprising:

   a fluid inlet (42) mounted to the ink-jet printer, the fluid inlet comprising:

   a hollow needle (162) having a base and a top, the base of the needle being in fluid communication with the trailing tube, the needle further defining a hole (168) near the top; and

   a sliding collar (170) encircling the needle, the sliding collar having a top surface and an inner surface in contact with the needle, the sliding collar being movable from a first position in which the inner surface seals the hole and the top surface is adjacent the top of the needle to a second position in which the hole is exposed; and

   a fluid outlet (28) mounted to the ink supply for engaging the fluid inlet when the ink supply is inserted into the ink-jet printer, the fluid outlet comprising:

   a hollow housing (99) having a first end in fluid communication with said quantity of ink;

   a septum (104) positioned to seal the second end of the housing; and

   a sealing member (102) positioned within the housing, the sealing member being movable between a first position in which the sealing member seals against the septum and a second position in which ink can flow passed the sealing member to the septum,

   wherein as the ink supply (20) is inserted into the ink-jet printer the housing (99) moves the sliding collar (170) from the first position to the second position to expose the hole (168) and the needle (162) pierces the septum (104) to move the sealing member (102) from the first position to the second position to allow the flow of ink from the housing and into the hole.

2. The system of claim 1 further comprising a first spring (172) positioned to bias the sliding collar (170) toward the first position.

3. The system of claim 2 further comprising a second spring (100) positioned to bias the sealing member (102) toward the first position.

4. The system of claim 3 further comprising a stop (182) formed on the sliding collar and a base plate

sticht, um das Abdichtungsbauglied (102) von der ersten Position in die zweite Position zu bewegen, um den Fluß von Tinte aus dem Gehäuse und in das Loch zu ermöglichen, wenn der Tintenvorrat (20) in den Tintenstrahldrucker eingefügt wird.

2. Das System gemäß Anspruch 1, das ferner eine erste Feder (172) aufweist, die positioniert ist, um die Gleitmanschette (170) zu der ersten Position hin vorzuspannen.

3. Das System gemäß Anspruch 2, das ferner eine zweite Feder (100) aufweist, die positioniert ist, um das Abdichtungsbauglied (102) zu der ersten Position hin vorzuspannen.

4. Das System gemäß Anspruch 3, das ferner einen Anschlag (182), der auf der Gleitmanschette gebildet ist, und eine Basisplatte (146), die in dem Drukker positioniert ist, aufweist, wobei der Anschlag die Basisplatte in Eingriff nimmt, um die erste Position der Gleitmanschette zu definieren.

5. Das System gemäß Anspruch 4, das ferner eine Kröpfabdeckung (106) aufweist, die über dem Septum positioniert ist und das Gehäuse in Eingriff nimmt, um das Septum in dem Gehäuse in Position zu halten.

6. Das System gemäß Anspruch 1, bei dem die obere Oberfläche (176) der Manschette und der untere Teil der Nadel (162) eine erste zusammenpassende Oberfläche definieren und die untere Oberfläche (106) der Kröpfabdeckung eine zweite zusammenpassende Oberfläche definiert, und wobei die erste zusammenpassende Oberfläche und die zweite zusammenpassende Oberfläche allgemein in der Form übereinstimmen, um zwischen dem Fluideinlaß und dem Fluidauslaß eingefangene Luft im wesentlichen zu beseitigen.

7. Ein Fluidauslaß (28) für einen Tintenvorrat (20), der eine Tintenmenge enthält und der in eine angedockte Position in einem Andockfach (38) eines Tintenstrahldruckers entfernbar einfügbar ist, wobei das Andockfach einen Fluideinlaß (42) zum Koppeln mit dem Fluidauslaß aufweist, um eine Fluidverbindung zwischen dem entfernbaren Tintenvorrat und dem Tintenstrahldrucker zu bilden, wobei der Fluidauslaß folgende Merkmale aufweist:

ein Hohlgehäuse (99) mit einem ersten Ende in einer Fluidverbindung mit der Tintenmenge;

ein Septum (104), das positioniert ist, um ein zweites Ende des Gehäuses (99) abzudichten; und

ein Abdichtungsbauglied (102), das in dem Gehäuse positioniert ist, wobei das Abdichtungsbauglied zwischen einer ersten Position, in der das Abdichtungsbauglied gegen das Septum abdichtet, und einer zweiten Position, in der Tinte an dem Abdichtungsbauglied vorbei zu dem Septum fließen kann, bewegbar ist, wobei das Septum (104) von einem Abschnitt des Fluideinlasses durchstochen werden kann, wobei beim Durchstechen des Septums der Abschnitt des Fluideinlasses das Abdichtungsbauglied von der ersten Position zu der zweiten Position bewegt, um einen Tintenfluß zwischen dem Fluideinlaß und dem Fluidauslaß zu ermöglichen.

8. Der Fluidauslaß gemäß Anspruch 7, der ferner eine Feder (100) aufweist, die positioniert ist, um das Abdichtungsbauglied zu der ersten Position hin vorzuspannen.

9. Der Fluidauslaß gemäß Anspruch 8, bei dem das Abdichtungsbauglied eine Kugel ist.

10. Der Fluidauslaß gemäß Anspruch 9, der ferner eine Kröpfabdeckung (106) aufweist, die über dem Septum positioniert ist und das Gehäuse in Eingriff nimmt, um das Septum in dem Gehäuse in Position zu halten.

Revendications

1. Système pour établir une connexion fluidique entre une réserve d'encre amovible (20) contenant une certaine quantité d'encre et une imprimante à jet d'encre dans laquelle peut être insérée la réserve d'encre, l'imprimante à jet d'encre ayant un tube arrière (169) pour délivrer l'encre dans une tête d'impression à jet d'encre, le système comprenant :

un orifice d'admission de fluide (42) monté sur l'imprimante à jet d'encre, l'orifice d'admission de fluide comprenant :

une aiguille creuse (162) ayant une base et une partie supérieure, la base de l'aiguille étant en communication fluidique avec le tube arrière, l'aiguille définissant en outre un trou (168) près de la partie supérieure ; et

une bague coulissante (170) entourant l'aiguille, la bague coulissante ayant une surface supérieure et une surface intérieure en contact avec l'aiguille, la bague coulissante étant mobile d'une première position, dans laquelle la surface intérieure

comprenant en outre un couvercle à sertir (106) placé sur le diaphragme et venant en prise avec le boîtier pour maintenir le diaphragme en place à l'intérieur du boîtier.

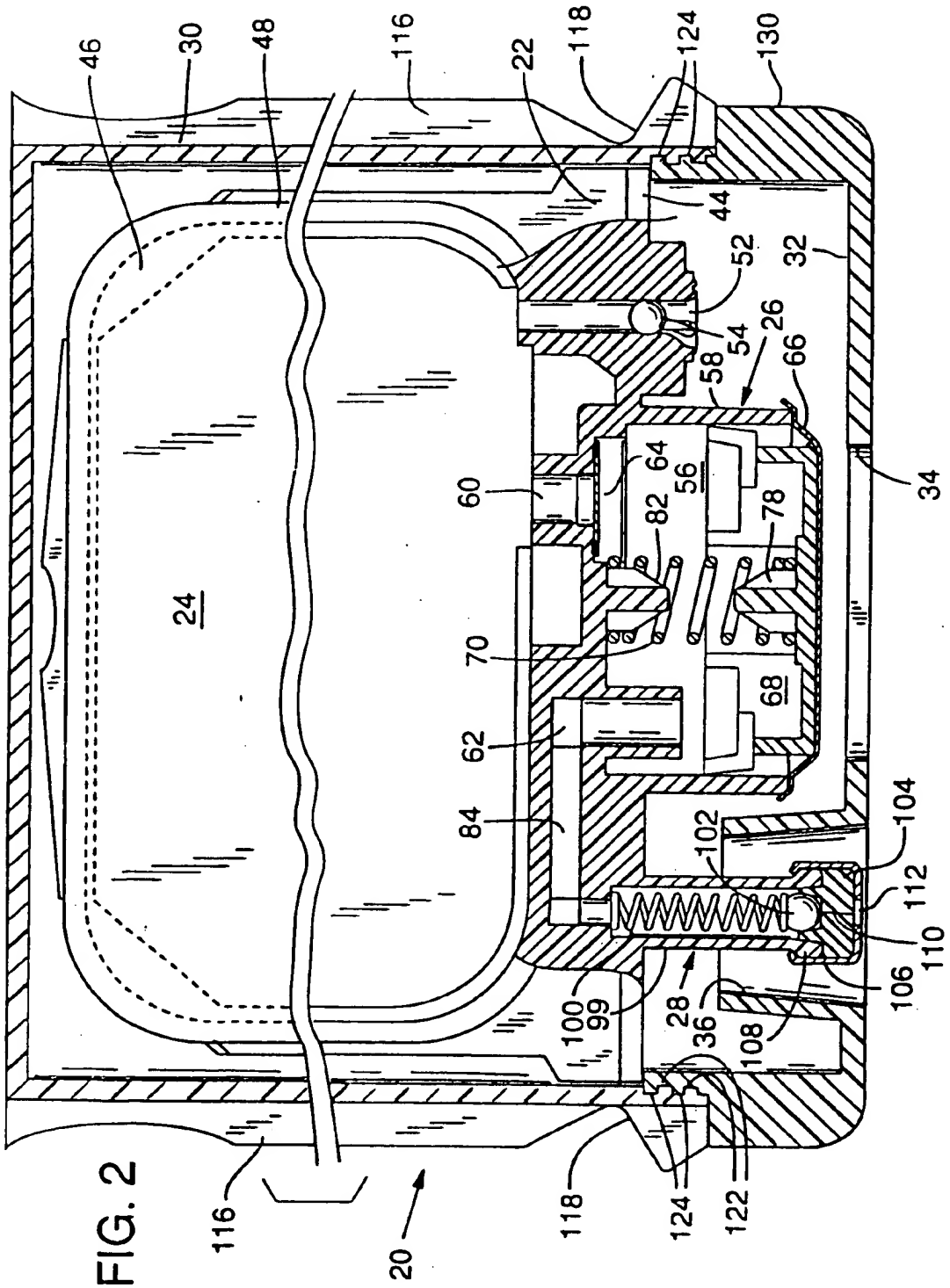
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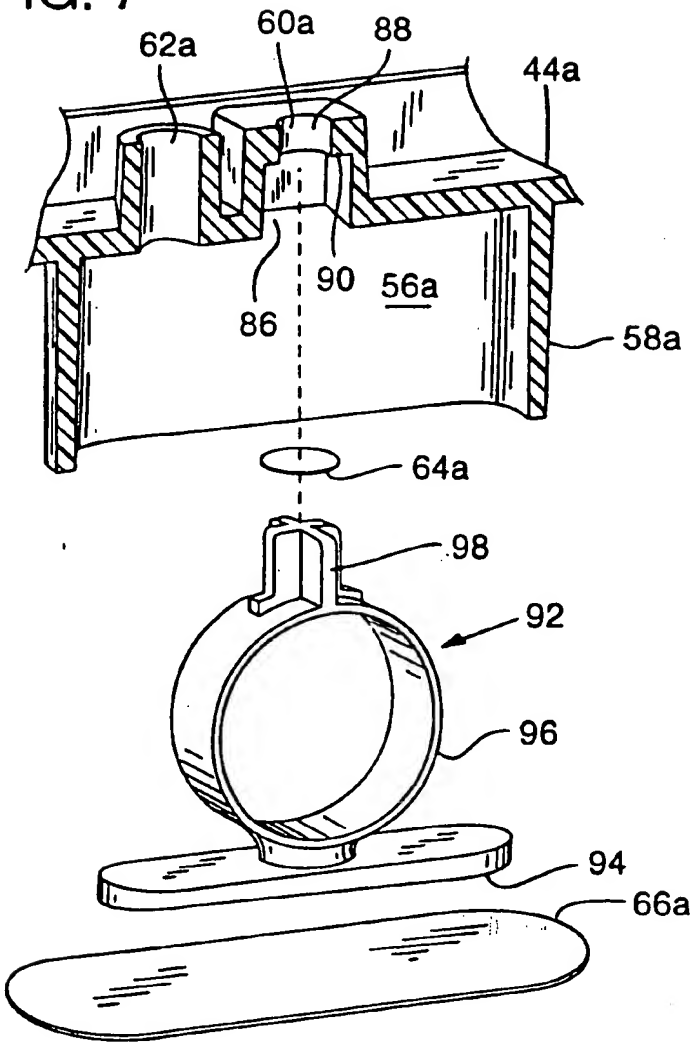
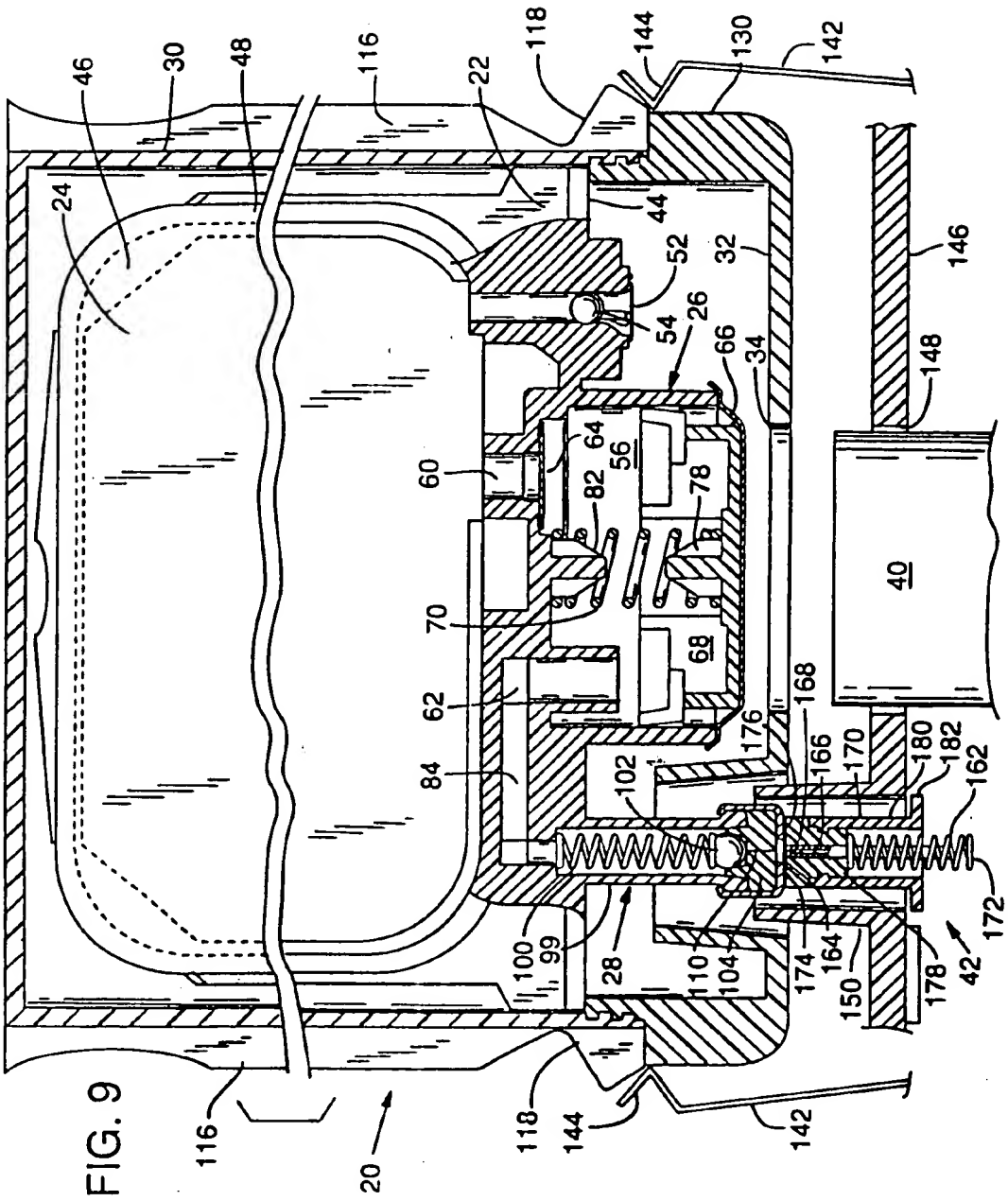
FIG. 2

FIG. 7

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180
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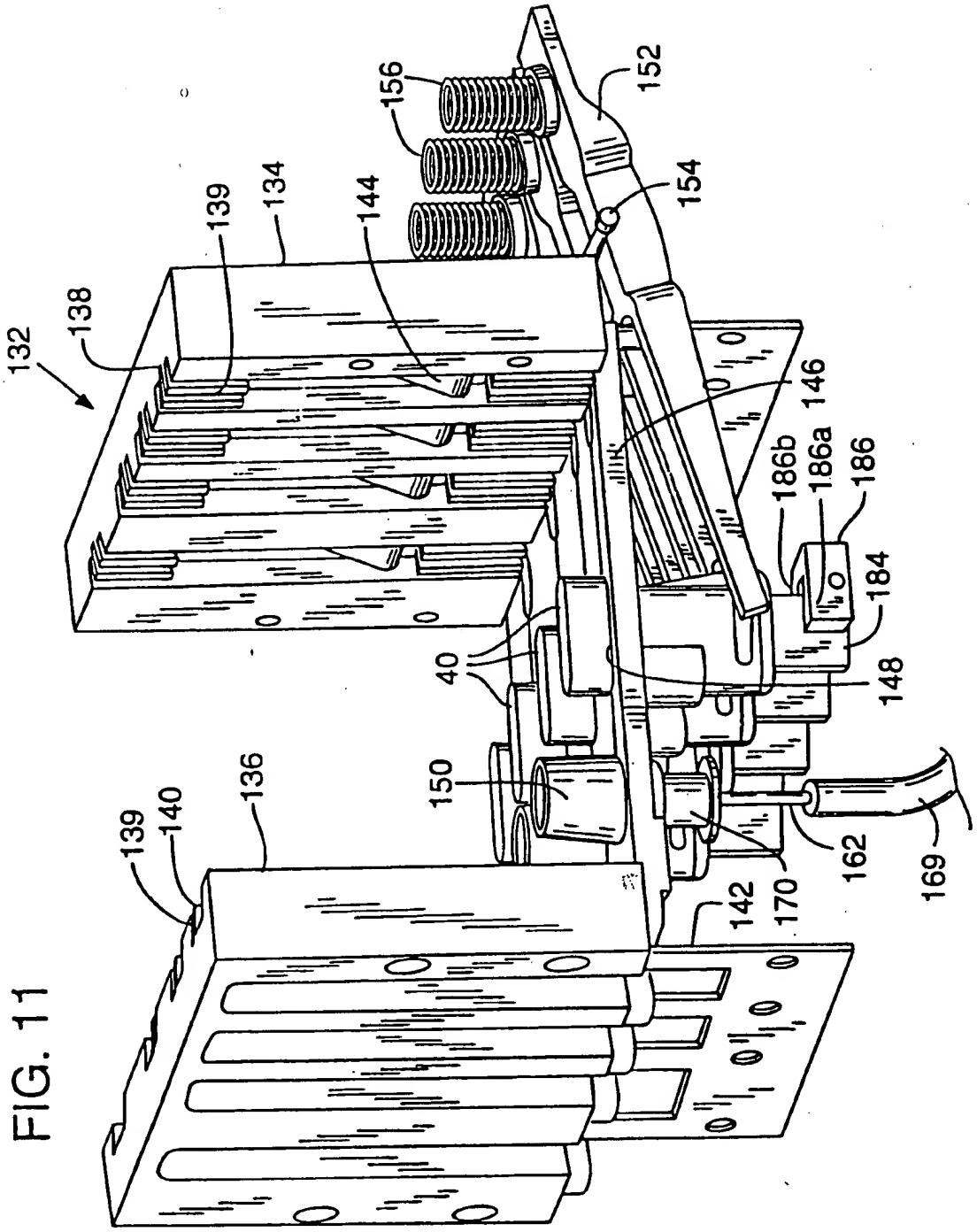
FIG. 9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186b
186a
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142
170

FIG. 11

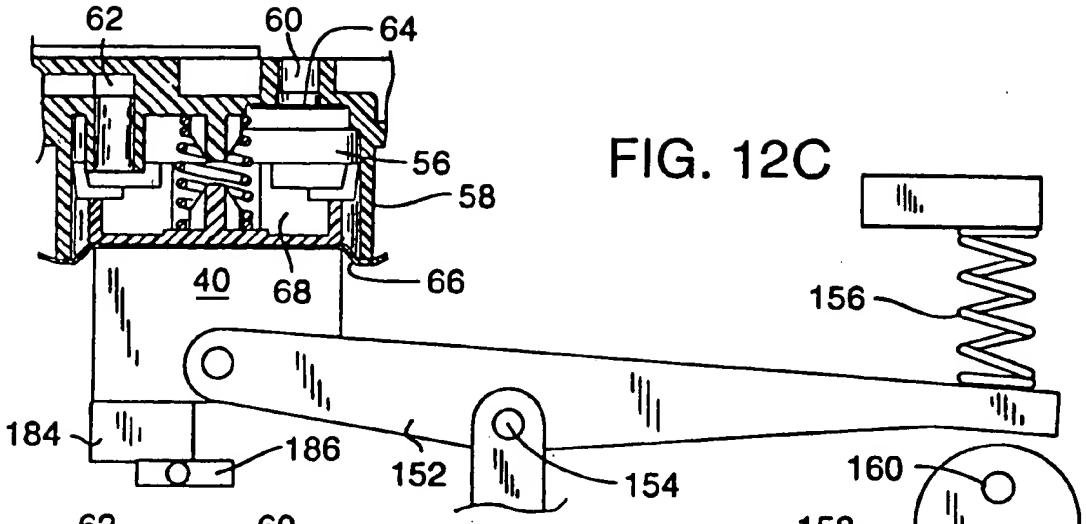

FIG. 12C

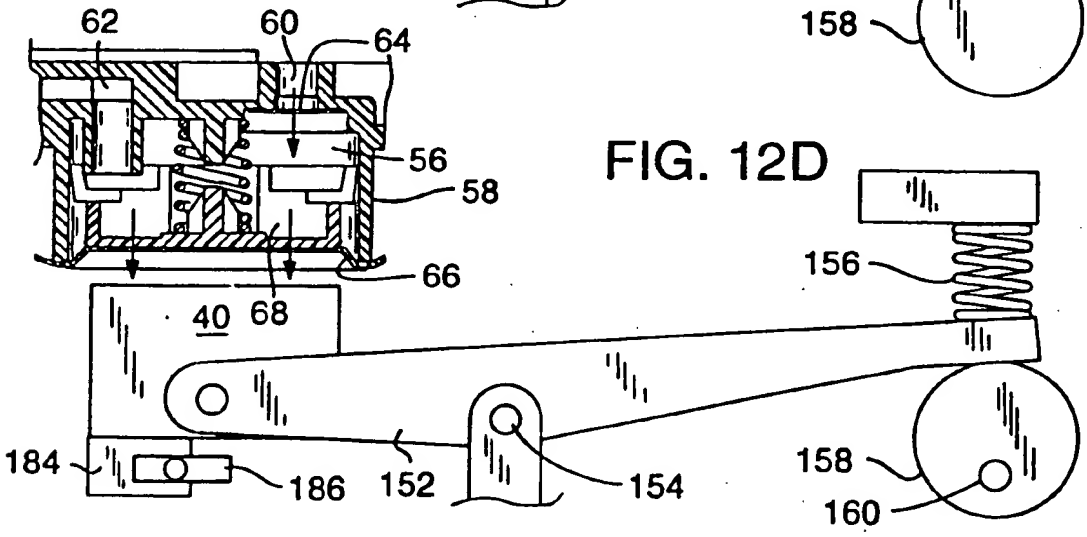

FIG. 12D

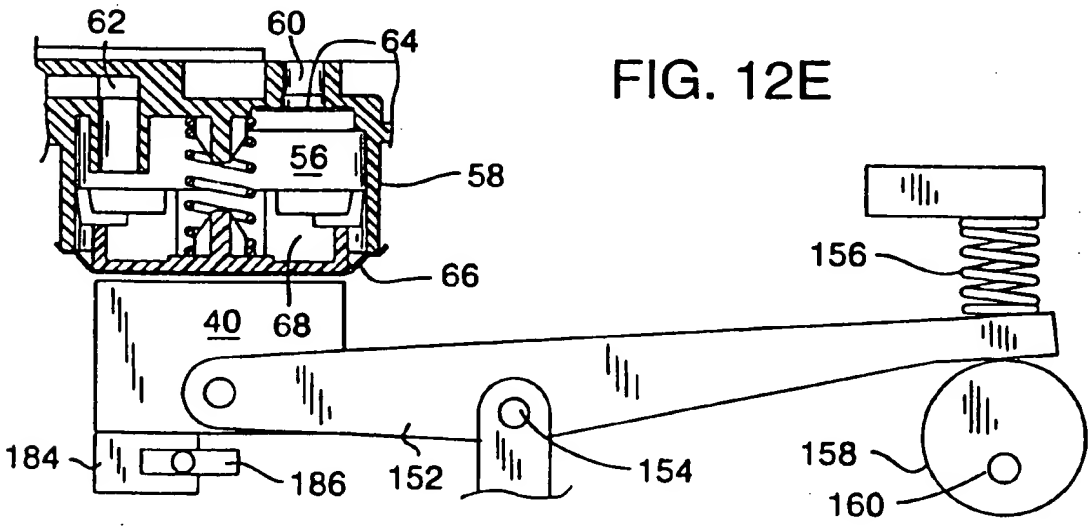

FIG. 12E